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The U.S. Forest Service's analysis of cumulative effects to wildlife: A study of legal standards, current practice, and ongoing challenges on a National Forest

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ABSTRACT

Cumulative effects analysis (CEA) allows natural resource managers to understand the status of resources in historical context, learn from past management actions, and adapt future activities accordingly. U.S. federal agencies are required to complete CEA as part of environmental impact assessment under the National Environmental Policy Act (NEPA). Past research on CEA as part of NEPA has identified significant deficiencies in CEA practice, suggested methodologies for handling difficult aspects of CEA, and analyzed the rise in litigation over CEA in U.S. courts. This article provides a review of the literature and legal standards related to CEA as it is done under NEPA and then examines current practice on a U.S. National Forest, utilizing qualitative methods in order to provide a detailed understanding of current approaches to CEA. Research objectives were to understand current practice, investigate ongoing challenges, and identify impediments to improvement. Methods included a systematic review of a set of NEPA documents and semi-structured interviews with practitioners, scientists, and members of the public. Findings indicate that the primary challenges associated with CEA include: issues of both geographic and temporal scale of analysis, confusion over the purpose of the requirement, the lack of monitoring data, and problems coordinating and disseminating data. Improved monitoring strategies and programmatic analyses could support improved CEA practice.

1. Introduction

Successful natural resource management requires an understanding of the synergistic effects of management actions at a variety of temporal and geographic scales. In the case of wildlife, for example, scientists have explained that managers must consider effects at the population scale, and not just at the scale of individual projects or management units, in order to understand effects to populations and species (Ruggiero et al., 1994). More generally, analyses of change over time and awareness of the effects of past actions allow natural resource managers to place current resource conditions in historical context, consider how past management actions have affected resources, and plan future management activities based on lessons learned (McCold and Saulsbury, 1996; MacDonald, 2000).

Cumulative effects often are analyzed as part of environmental impact assessment. Most U.S. states have procedures for completing cumulative effects analysis (CEA) (Ma et al., 2009), and many other countries include CEA in project-level environmental impact assessment (Therivel and Ross, 2007). CEA is completed by U.S. federal agencies as part of environmental impact assessment under the National Environmental Policy Act of 1969 (NEPA). This article provides an overview of the CEA requirement under NEPA and an introduction to some of the challenges associated with its interpretation and implementation. It then turns to a study of implementation of the requirement by a U.S. federal agency in order to provide insight into current practice, discuss primary challenges in implementation, and identify opportunities for improvement.

1.1. An overview of NEPA and the CEA requirement

There are a number of intents built into NEPA, including clearer planning procedures, ecosystem-level analysis, exploration of alternatives in planning, and increased transparency, judicial oversight, and opportunities for public participation (Culhane, 1990). Despite this mixture of intents, however, it is well-established that two primary aims of the Act are to: 1) force agencies to take a "hard look" at the potential environmental impacts of their actions, and 2) disclose to the public how they considered those impacts and decided upon a course of action (see Robertson v. Methow Valley Citizen Council (1989) and Karkkainen, 2002). In other words, the requirements of NEPA are meant to lead both to improved decision-making as well as improved disclosure. By requiring analysis and disclosure of environmental consequences, NEPA is meant to lead to more rational and environmentally sound courses of action, but it does not require agencies to choose a more environmentally benign course of action.

Under NEPA, agencies prepare environmental assessments (EAs) for projects that will not likely have significant effects and environmental impact statements (EISs) for projects with potentially significant impacts. In both types of environmental impact assessments, agencies

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must consider direct, indirect, and cumulative effects. NEPA regulations define a cumulative effect as: "The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 C.F.R. §1508.7 [2008]). The requirement asks federal agencies to look at the big picture and place the effects of a single project into a broader geographic and temporal context. It is an essential facet of NEPA analysis, which was meant to move government agencies beyond incremental decision-making and towards "the early identification of environmental consequences of government action and the understanding of government proposals in a larger environmental context" (Thatcher, 1990, p. 612). Thatcher (1990) goes on to say, "[T]he most complete analysis of cumulative impacts, while potentially daunting in scope, represents the best hope to achieve NEPA's mandate…" (Thatcher, 1990, p. 612–13).

In the past, CEA has been largely ignored in NEPA documents. Studies in the 1990s found that less than half of EAs included any mention of CEA (McCold and Holman, 1995; Burris and Canter, 1997a). A study on CEA in EISs from the 1990s determined that "inconsistencies and inadequacies still exist" in the analyses and that there is a "lack of adequate documentation of the CEA process (or lack of adequate CEA procedures in general)" (Cooper and Canter, 1997, p. 385, 405). Beginning in the latter half of the 1990s, agencies began to lose numerous legal challenges for failure to perform adequate CEA in their NEPA documents. In particular, the U.S. Forest Service (USFS) faced a barrage of litigation involving CEA challenges. In the Ninth Circuit Court of Appeals, the USFS has faced and lost more cases than any other agency, losing 69% of published cases on this topic between 1994 and 2005 (Smith, 2006). The primary reason the agency lost was for failure to appropriately analyze past, present, and reasonably foreseeable future actions; other reasons included lack of data or a clear rationale for CEA conclusions, the geographic scale of analysis being too small, illegal segmenting of projects, outdated data, and tiering to a non-NEPA document (Smith, 2006). Smith (2006) notes that most cases were lost because the agency did not comply with CEA requirements, and not because the courts were interpreting CEA in a novel way or requiring a perfect analysis. One possible exception, notes Smith (2006), is the Lands Council v. Powell (2004) case, discussed below in Section 1.2.

1.2. The challenge of scale

Determining the appropriate geographic and temporal scales of analysis is one of the most perplexing aspects of CEA. A particularly difficult question is how to comply with NEPA when projects have small, incremental effects that contribute to significant cumulative effects. For instance, should any project with net carbon emissions require an EIS because of contributions to the significant cumulative impact of climate change? According to Eccleston (2006), a strict reading of the regulations implies that any project that contributes *at all* to significant cumulative effects requires preparation of an EIS. He writes, however, that this is an untenable interpretation of the regulations; not every project should require a full-blown EIS simply because it has an incremental impact on a significant cumulative impact. McCold and Saulsbury (1996) explain that in such cases programmatic assessment (assessment on a scale that would cover multiple actions or projects) of cumulative effects would be appropriate, allowing for larger-scale assessment while also providing an opportunity for deliberation about social values regarding resource use. In reality, though, agencies often reserve CEA for project-level analysis when the details of on-the-ground activities are clearer. Herein lies a major conundrum with regard to CEA: when is the most appropriate time for agencies to look at the big picture, while also bearing in mind the specifics of project implementation?

As for how to handle cumulative effects in project-level analyses, Eccleston (2006) recommends that the "Significant Departure Principle" be employed to help NEPA practitioners recognize the situations in which an EIS is required. By this concept, an impact would be considered significant in the NEPA sense, therefore triggering the preparation of an EIS, if it constituted a significant departure from the existing condition *or* if a threshold were crossed. However, Eccleston (2006) acknowledges a serious problem with this approach, which is that many small or incremental impacts to a resource might be approved without preparation of an EIS, particularly when thresholds are not crossed or have not been established. The result of this situation might be a cumulatively significant impact that is not accounted for anywhere. For wildlife species, for example, many thousands of acres of habitat might be lost in small, incremental steps but never be accounted for until a viability threshold is crossed (assuming such thresholds have been established).

Methodologies for assessing effects from past actions have been another vexing aspect of CEA (McCold and Saulsbury, 1996; MacDonald, 2000; Eccleston, 2006). A key challenge is the identification of an appropriate reference point for comparison with current conditions. McCold and Saulsbury (1996) write that most agencies inappropriately use the existing environment as the baseline for resource conditions and assess potential impacts as departures from this current condition or baseline. This practice feeds into what has been called the "shifting baseline syndrome," whereby manager's expectations for resource conditions decline over time (Pauly, 1995 as cited in Tear et al., 2005). The approach often fails to account for the effects of past actions and focuses on limiting future significant impacts (McCold and Saulsbury, 1996). This can be problematic when a resource has already sustained significant impacts; future actions may be viewed as having minor impacts even when they may exacerbate already significant impacts. In light of these issues, some authors have written that, although acquiring comprehensive information on past actions and effects is a serious challenge, it is critical that a CEA "put the current condition and predicted change into historical context" (MacDonald, 2000, p. 305).

Several recent legal cases in the Ninth Circuit highlight the challenge of past actions analysis as part of CEA. At issue in Lands Council v. Powell (2004) (hereinafter *Lands Council*) was a proposed watershed restoration project on the Idaho Panhandle National Forest that included logging in an area with a history of heavy timber extraction. In its assessment of the agency's CEA, the court wrote: "The [EIS] generally describes the past timber harvests…and asserts that timber harvests have contributed to the environmental problems in the Project area. But there is no catalog of past projects and no discussion of how those projects (and differences between the projects) have harmed the environment" (Lands Council, 2004, p. 1027). The court explained it already had been established as a general rule under NEPA that a CEA must include, at a minimum, a catalog, or list, of other past, present, and future projects *and* information on the environmental effects of these projects (other cases also emphasize this point; see, for example, Natural Resources Defense Council v. United States Forest Service (2005)). According to the court, such a list would provide documentation of what projects had been considered as part of the CEA and allow for comparisons of the alternatives and their possible effects in light of documented effects from past activities. Importantly, following the court's direction on this matter would require access to data and analysis of the effects of individual past projects. For this reason, and because the court seemed to be prescribing a particular approach to CEA, the decision sparked some controversy.

In 2005 in response to the decision in Lands Council v. Powell (2004), the CEQ issued a memorandum entitled "Guidance on the Consideration of Past Actions in Cumulative Effects Analysis" (CEQ, 2005). CEQ explained that a detailed cataloging of past projects and their effects is only necessary to the extent that such a process would assist the agency in identifying cumulative effects or determining the effects of

alternative proposed courses of action. The memo stated, "Generally, agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions" (CEQ, 2005, p. 2). The USFS has promulgated regulations in line with CEQ's guidance (36 C.F.R. §220 [2008]), making it more likely that courts will defer to this practice in the future. Some have noted potential problems with this approach. For example, Grothaus (2007) explains: "When relevant prior actions are lumped into the environmental baseline and considered in the aggregate, the lessons of such actions are effectively removed from the decision making process. Such aggregation may also lead to a false sense of security, in which prior degradation is taken for granted because it is considered part of the environmental baseline" (p. 888). It is key to note, then, that this matter of how to analyze past actions has resulted in legal challenges from members of the public and apparent controversy between the courts and the executive branch as to what is necessary as part of CEA.

1.3. The relationship of monitoring and adaptive management to CEA

Another key area of ongoing discussion regarding CEA and NEPA implementation revolves around the limits of predictive analysis and the importance of monitoring and adaptive management. Earlier assessments of NEPA found that, in general, the predictive capacity exhibited in NEPA analyses was low (Culhane, 1990; Karkkainen, 2002). In terms of environmental variables, the limits of prediction have been increasingly emphasized in the academic literature (Sarewitz et al., 2000). NEPA expert Bradley Karkkainen (2002) has argued that NEPA focuses too much on "comprehensiveness and clairvoyance" and provides no mechanisms to determine whether predictions are accurate or whether mitigation measures are effective (p. 902). His assessment of the problem relates to challenges with CEA: "An agency that does not monitor the actual environmental consequences of its activities will have little capacity to develop useful performance benchmarks against which to measure present and proposed activities…. Consequently, it will have an underdeveloped capacity to evaluate and learn from its own experience and to improve its performance over time" (Karkkainen, 2002, p. 931).

Monitoring is a central component of adaptive management, which involves the adaptation of management activities based on monitoring information from past activities and management experiments; numerous authors see adaptive management and monitoring as critical facets of improving public land and natural resource management (see for example, Lee, 1993; Karkkainen, 2003; Sarewitz et al., 2000; Stankey et al., 2003; Ruhl, 2008). CEQ also echoes this, writing, "[A]n adaptive environmental management approach may be the best means of attaining both NEPA's goals and an agency's mission" (CEQ, 1997, p. 33). However, they also note that for adaptive management to work, funding must be available to support monitoring and for any additional decisions that have to be made in light of new information (CEQ, 2003).

Despite its utility and importance, monitoring has been a persistent problem in natural resource management. There are considerable disincentives for agencies to monitor, including the potential for monitoring information to be generated that shows management actions are having negative impacts (Doremus, 2008). Doremus (2008) explains that it has been difficult to maintain the political and fiscal will to implement successful monitoring programs and that no federal agency has in place a systematic monitoring program to assess whether predictions in NEPA documents are accurate. Without a systematic approach to monitoring, it is difficult for an agency to know how resource conditions have changed over time, understand the effects of current and past projects, or practice adaptive management over time. This poses a serious impediment to understanding cumulative effects, their causes, and the potential impacts of proposed projects.

1.4. Summary

This article explores some of these challenges associated with CEA, using an example of the USFS' implementation of the requirement, and focuses on how CEA is done for wildlife. CEA is particularly relevant when planning for the conservation of resources such as wildlife populations that may respond over broad geographic scales and long periods of time. The USFS is responsible for approximately 193 million acres of public land and is legally required to "provide for diversity of plant and animal communities" (16 U.S.C. §1604 [g][3][B] [2006]). Current planning regulations also require individual forests to "maintain viable populations" of vertebrate species (36 C.F.R. 219.19 [2000]), although the Obama administration is in the process of revising the planning rule (see http://fs.usda.gov/planningrule, last accessed Mar. 11, 2011). In the past, the USFS has identified CEA as one of the primary challenges in forest planning, explaining that CEA has not been handled effectively at the forest plan level (73 Fed. Reg. 21468, Apr. 21, 2008). Scientists have identified CEA as a key aspect of effective biodiversity conservation in forest planning, and one that was threatened by recent planning rule revisions (see Management by Exclusion (a House Oversight Hearing), 2007). Therefore, the matter of CEA is of ongoing importance for NEPA implementation and both forest and wildlife conservation planning.

2. Methods

This article was part of a broader research project that involved a detailed legal and historical analysis of the CEA requirement, which is drawn upon herein, and a study of the Idaho Panhandle National Forest's (IPNF) implementation of the CEA requirement. Research on CEA in the past has been broader in scope, involving surveys and content analysis of larger samples of environmental impact assessments (McCold and Holman, 1995; Burris and Canter, 1997a, 1997b; Cooper and Canter, 1997). In a situation such as this, a case study or detailed examination of a smaller sample is warranted and valuable (Gerring, 2004). The IPNF served as an informative example for exploring this topic for several reasons. In the Ninth Circuit, the federal appellate court that hears the most cases involving public lands, the USFS has faced more litigation on this topic than any other federal agency, with the majority of this litigation occurring in Region 1 (Smith, 2006). It was valuable to consider a management unit (National Forest) from the USFS in Region 1, where there has been consistent legal attention paid to CEA. These National Forests are likely paying close attention to CEA and may be providing more in-depth CEA given the high level of legal scrutiny in the region. Interviewees in Region 1 could be expected to have relatively rich perspectives on this topic, given its prevalence as a key issue in NEPA analysis and forest management in the Northern Rockies Region. The IPNF was an ideal choice because of its involvement in several recent decisions on CEA and wildlife analysis (see Lands Council v. Powell (2004) and Lands Council v. McNair (2007, 2008 en banc)).

This paper discusses the findings from a document review of a sample of EISs for projects that would be likely to have significant effects in general and specifically to wildlife. To allow for some comparisons across documents with similar proposed actions, NEPA documents from 2006 to 2007 with a listed project purpose of either "forest products" or "fuels management" were considered in order to capture any projects involving timber harvest (a similar sample from 2002 to 2003 was also reviewed but in not covered in this piece). The majority of USFS litigation historically has challenged logging projects (Keele et al., 2006), which are contentious and viewed as being at odds with conservation interests, in part due to the potential for alteration and fragmentation of habitats. Therefore, one could assume this sample of projects would involve CEA relevant for wildlife. Only projects for which environmental impact statements (EISs) had been prepared were included in the sample; EISs are prepared for projects

with potentially significant impacts and could be expected to include more detailed and thorough examples of CEA than one would find in EAs. A two-year timeframe using these parameters yielded four EISs from various districts (USFS, 2006a, 2006b, 2007a, 2007b). Although other examples of EISs were used for reference and comparison during the research, this project did not include comprehensive review of a sample of EISs from other forests.

The purpose of the document analysis was to understand the general approach to CEA on the IPNF and the approach specifically for wildlife. A qualitative document review was conducted, utilizing a list of questions informed by past research on CEA (Burris and Canter, 1997a; Cooper and Canter, 1997), to assess how CEA was approached in each document. For example, some of the questions included: What is the scale of CEA for each resource? Is the choice of scale explained and justified? Are procedures and guidelines for conducting CEA explained? How are past actions discussed? What were public comments related to CEA? Each document was systematically reviewed and all relevant text for each question was compiled.

To get additional perspective on current CEA practice and challenges, in-depth interviews with IPNF personnel were also conducted. Interviewees included NEPA coordinators, interdisciplinary team members and specialists, and line officers; USFS staff from the Northern Region Office; scientists with the USFS research branch; and other parties, including outside scientists and individuals who had commented substantively on CEA in the EISs reviewed. Interviews were qualitative, semi-structured, and confidential; interviewees were identified through both purposive and snowball sampling (Singleton and Straits, 2009). Initial interviewees included staff on the IPNF involved in conducting NEPA analysis. The sample was broadened over time as individuals suggested other potential interviewees both on the IPNF and beyond the level of the IPNF. Interview questions focused on how CEA is currently practiced, strengths and weaknesses of the current approach, impediments to improvement, and avenues for improving CEA; questions varied to some extent depending on the expertise of the individual interviewed. A total of 31 individuals were interviewed for this project. Due to the sensitivity of the subject, interviews were not tape-recorded. Instead, detailed notes were taken and then transcribed, interviews were reviewed for themes, responses to specific questions were collated, and results were organized according to topic areas and themes.

3. Findings: the IPNF's approach to CEA in NEPA documents

CEA was included in all four of the 2006–2007 EISs reviewed for all resources, albeit to different extents depending on the resource and the relevance of cumulative effects. This alone was an important finding, given that past research found not all NEPA documents included CEA. In all EISs, the IPNF's response to the issue of past actions analysis was detailed in a section entitled the "Cumulative Effects Response" (the CEA response was included in different parts of the EISs; see, for example, USFS, 2007a, ch. 3). This is, as some interviewees called it, a boilerplate CEA response developed by the IPNF after the Lands Council (2004) decision. This response makes several primary points. The first is that although sometimes a catalog of past projects and their environmental effects might be useful for predicting cumulative effects, NEPA regulations do not require that agencies exhaustively catalog past projects. The EISs reviewed for 2006–2007 include a list of past timber harvests, along with the lists of past, present, and reasonably foreseeable future projects and activities that might be relevant for CEA for individual resources. These were listed in general terms; examples include "firewood gathering", "hunting", and "road maintenance activities." The second point is that CEA generally is supposed to focus on the incremental impact of the proposed action in combination with the aggregate effects of past, present, and reasonably foreseeable future actions; detailing the effects of individual actions often is no more useful than considering current conditions, in which the aggregate effects of all past actions are embedded. Third, according to the IPNF, forestry practices have changed too significantly and rapidly for an analysis of past activities and their effects to be useful in assessing the possible effects of the alternatives presented in current EISs. For this reason, the IPNF writes that information from past projects would not be particularly useful for understanding effects from proposed projects, although monitoring information will be included when it is available.

In order to understand what this approach means in practice, it is useful to consider how it plays out for a particular resource. Wildlife is an interesting case to consider because populations have the potential to see effects over long periods of time and broad geographic scales (Mills, 2007). On the IPNF, effects to wildlife are analyzed in terms of habitat-based variables; this practice is common on public lands and has been deemed acceptable in the Ninth Circuit (see Inland Empire Public Lands Council v. USFS (1996) and Noon et al., 2008 for explanation). Because sufficient population data is not available, habitat is used as a proxy for estimating population abundance and distribution in environmental effects analyses. It is worth noting, despite the legal acceptability of this practice, that habitat-based analyses alone are insufficient, from a scientific perspective, for wildlife conservation planning (Noon et al., 2003; Mills, 2007; Cushman et al., 2008; Noon et al., 2008).

The scale of the CEA in IPNF documents varies by species. For most species, the cumulative effects area is the project area boundary. According to the IPNF, this is because the project area boundary often is the size of multiple home ranges for species, reflects topographic features that govern species movement, and represents the point of diminishing effects. In other words, broadening the CEA area makes a project's effects seem relatively minor within the broader landscape. This raises the question of whether and at what point larger-scale and forest-wide assessments of population status are undertaken. For most wildlife species, scientists explain that effects must be considered at scales larger than project areas in order to reflect cumulative effects on habitat fragmentation, population status, and population connectivity (Ruggiero et al., 1994; Cushman, 2006; Mills, 2007). Past actions and their effects are dealt with by considering the "environmental baseline," by which the IPNF means the current condition of species' habitat. The EISs included lists of past actions, but no EIS in the analysis for wildlife includes a detailed list of past actions *and* their effects. In most cases the effects of past actions are integrated into the description of the current condition of the resource. In order to understand what exactly this means for individual species, it is useful to consider several examples.

Three species provide examples of different approaches to CEA for wildlife. For lynx (*Lynx canadensis*), management guidelines and the approach to CEA are relatively straightforward. An interagency conservation strategy, developed by the USFS in conjunction with other agencies, including the U.S. Fish and Wildlife Service, after lynx were listed as threatened under the Endangered Species Act of 1973, guides management actions vis-à-vis lynx and sets some cumulative impact limits (Reudiger et al., 2000). In areas of lynx habitat the USFS designates theoretical homeranges for individual lynx and meets specific management standards within these homeranges. For example, the USFS cannot convert more than 15% of lynx habitat to an unsuitable condition within 10 years and cannot reduce suitable habitat at all if more than 30% of the homerange is already in an unsuitable condition. These standards serve as cumulative impact thresholds for habitat alteration both spatially and temporally. The existing condition for lynx in any project area is described as the number of theoretical homeranges in the project area, and effects are presented in terms of percentage changes to suitable habitat. Changes to suitable habitat over the last decade are also disclosed. Cumulative effects are deemed insignificant as long as these guidelines are met.

Past, present, and reasonably foreseeable future activities are considered in general, qualitative terms. For example, one EIS (USFS,

2006a) explains: "The road construction associated with [past] sales increased access for trappers and snowmobilers, potentially causing negative impacts to lynx through increased trapping mortality and snow compaction allowing access to lynx habitat for competing predators" (p. 4–59). The section concludes, "These activities would not have cumulative significant impacts when added to the proposed action, since the effects are already incorporated into the environmental baseline" (p. 4–59). This assertion concludes nearly every CEA for wildlife in the EISs reviewed. In this case, the conclusion is justified, at least in part. Management guidelines set cumulative impact thresholds to prevent *further* significant cumulative effects to lynx and the loss of any suitable homeranges. However, it is notable that there is no disclosure of how populations are thought to have declined over time in the area, no assessment in the EISs of the extent to which lynx may have already sustained cumulatively significant effects on the IPNF, and only general analysis of how past actions and events on the IPNF may have contributed to those effects. A key question is whether this information is important to include in a CEA; this is considered in more detail in Section 4.1.

The analysis for Fisher (*Martes pennanti*), which the Regional Forester has designated as a sensitive species requiring species-specific analysis and consideration of population viability, provides further insight into CEA practice. Interviewees suggested that fisher populations are likely at serious risk on the IPNF, and the Northern Rockies population of fisher has recently been petitioned for listing under the Endangered Species Act of 1973. Unlike lynx, fisher does not benefit from a comprehensive, inter-agency management strategy and cumulative impact thresholds are unclear. Managers primarily analyze effects in terms of changes to suitable habitat, which they designate based on the presence of mature and old-growth stands. The general goal is to maintain or improve the quality of subdrainages in terms of fisher habitat, or mature and old-growth stands. The IPNF notes that fisher habitat is difficult to model because of a lack of information on the species' habitat requirements and limitations in accounting for various habitat characteristics with timber stand data (USFS, 2006a).

An analysis of how subdrainages may be affected is combined with information on past activities to provide a picture of cumulative effects. For instance, one EIS (USFS, 2006a) explains: "In combination with past natural and human-caused events, the proposed action would reduce the quantity of suitable fisher denning habitat. However, given the low density of fisher populations, it is unlikely that they are limited by denning habitat. Previous activities would not have cumulatively significant impacts when added to the proposed action, since the effects are already incorporated into the environmental baseline (USFS, 2006a, p. 4–79)." In this case, there is no apparent basis for the conclusion that minimal reductions in suitable habitat are insignificant. It is unclear how much area should remain in a suitable denning condition to support a homerange, how many homeranges should be conserved and in what proximity to each other to support a viable population, or how much habitat could be converted in an area without threatening populations. Without any thresholds to provide some context for projects that eliminate small portions of habitat, there is no clear basis for asserting there are no significant cumulative effects. As was the case with lynx, there is also no clear picture of how habitat or populations have been affected over time in the area or on the forest. These factors make it difficult to assess cumulative effects either generally or as a result of management actions in relationship to past conditions or viability thresholds. One event that would cause the identification of significant cumulative effects would be if the species were listed as threatened or endangered. However, relying upon listing to trigger the identification of significant impacts is undesirable, because in the U.S. species are often listed well after the crossing of what would be considered viability thresholds (Crumpacker, 1998).

One final example provides a sense of a slightly different approach to CEA for wildlife. The analysis for pileated woodpeckers (*Dryocopus pileatus*) focuses on the importance of large-diameter snag habitat (see, for example, USFS, 2007b) and the preservation of current homeranges. In this case again there is no disclosure of specifically how populations or habitat may have been affected over time, what such changes in conditions might mean for populations, and whether the resource might have already sustained significant impacts. However, in this case, a kind of threshold has been established for this species. An internal agency assessment (Samson, 2006a) serves as the basis for the finding of no significant cumulative effects for pileated woodpeckers and several other avian species across the region. It finds that ample habitat remains for this species on the IPNF and asserts that no thresholds will be crossed that may threaten species viability. This sort of assessment of the status of species at a larger scale and with thresholds for habitat maintenance at local scales might be useful in order to put project-level effects into an appropriate context for wildlife populations. One interviewee stated that this type of regional analysis was very helpful for completing project-level CEA. However, several interviewees, including biologists with the National Forest System, USFS research scientists, and outside scientists questioned the scientific validity of this programmatic viability assessment, calling it "a very blunt tool," stating that it should have been completed by someone outside of the National Forest System, and explaining that it should have undergone some kind of peer-review, although one interviewee asserted it never would have survived such review. Members of the public also raised this question in their comments on EISs (see USFS, 2007b, Appendix A, p. 141). While a programmatic assessment of this kind is important for understanding the status of populations beyond the project level, such an assessment must be scientifically valid and reliable if it is to be used to support project-level effects analyses for species that may be imperiled.

4. Findings and discussion: challenges associated with CEA practice

The point here is not to criticize the IPNF or practice in the Northern Region; indeed, the IPNF is following legal and agency guidance on how to conduct CEA. The purpose instead is to understand what can we learn from this example about the broader challenges associated with implementation of the CEA requirement and what are potential ways forward. In order to provide some perspective on these questions, this section focuses on two primary aspects of CEA that interviewees highlighted and discussed during the research.

4.1. Determining the scale and scope of analysis

Determining the appropriate temporal and geographic scale of a CEA is a long-standing challenge (McCold and Saulsbury, 1996; MacDonald, 2000; Eccleston, 2006). Confounding this issue is the fact that, among interviewees, there was limited agreement on the intent of CEA and the role of past actions analysis. Those interviewees from conservation groups who discussed in detail the role of past actions (50% of all interviewees in this group) stated that at some point in planning there should be a narrative of what has been done in an area, what has been learned from monitoring activities, and an assessment of cumulative effects. On the other hand, several USFS personnel emphasized that CEA is only meant to inform the decision at hand. This perspective in many ways echoes the guidance from CEQ (2005) emphasizing that CEA is "forward-looking." Several USFS staff argued that analyses for projects with minimal impacts do not need to include a detailed CEA of past actions; such an assessment would be interesting, but would do little to inform the present decision.

A key point to recall is that NEPA is about both improved decision-making and disclosure of factors considered during decision-making, and the requirements of the law are meant to serve these purposes (Karkkainen, 2002). The question, then, is whether knowledge of past impacts is an important part of decision-making and something that

should be or is required to be included in a NEPA document. A number of authors writing about CEA explain that NEPA's disclosure requirements lend credence to the notion that CEA, at some level of planning, should include a picture of significant changes to a resource over time (McCold and Saulsbury, 1996; MacDonald, 2000; Eccleston, 2006). Even if a project itself will not have significant impacts or cause a threshold to be crossed, the resource still may have sustained significant cumulative effects, and this is part of what is to be considered as part of the NEPA process and in decision-making. The conundrum is determining how and when to account for significant past impacts when individual projects have only incremental effects.

In the case of the USFS and wildlife analysis, the obligation to consider cumulative effects at a scale that is scientifically valid also is implicated under the National Forest Management Act of 1976 (NFMA). The USFS has a legal obligation to maintain species viability and well-distributed habitat over individual National Forests (36 C.F.R. §219.19 [2000]). In the case of wildlife species, the analysis area should be roughly equivalent to the boundaries of a wildlife population or at least should be expanded beyond the project area so that the analysis area and the scale at which effects are relevant are more analogous (Ruggiero et al., 1994). At some point individual forests must look beyond the project area at the cumulative effects from actions on a larger scale in order to address effects to populations, assess viability at the forest level, and contextualize project-level effects.

For these reasons, a broad picture of long-term effects, even if the project at hand will have only minimal effects, is important for decision-making and is key to complying with legal requirements under both NEPA and NFMA. For resources that are affected over broad scales, it might be most useful for projects to include their own analysis but also to tier to a programmatic analysis that considers the cumulative effects of multiple actions and puts project effects into context. As MacDonald (2000) explains, ideally "a tiering or hierarchy of [CEAs] is needed to address fully the potential range of [cumulative effects]" (p. 312). In the public comments for one of the EISs reviewed for this research, a member of the public also makes this point: "According to Forest Service experts, population viability analysis is not plausible or logical, from a scientific standpoint, at the project level such as the scale of a timber sale(s), absent some tiering to a large-scaled study" (USFS, 2006a, p. F-17). Members of the public, the USFS, and scholarly experts seem to agree that some kind of tiering is necessary to capture broad-scale effects.

One option would be to conduct CEA for resources in a process that complements project planning, such as forest plan implementation monitoring. Such a process could rely on a relatively constant stream of incoming monitoring information and provide a look at effects from multiple projects on larger scales. Managers could then rely upon broader scale assessments for contextualizing their own project's potential effects. Additionally, although they are not available for all species, regional strategies (such as the lynx conservation strategy) and regional assessments of habitat availability by forest (Samson, 2006b) provide some broader context for project-level analyses. These assessments set forest-wide thresholds and take a Region-wide look at the viability of some species; however, there remains the question of scientific validity of some internally completed assessments.

A persistent challenge is how to capture cumulative effects from past actions and events. Several USFS interviewees questioned the utility of listing past actions without information on the effects of those actions, explaining that cataloging alone is not a valuable exercise. The question remains, however, as to what methodology would be useful for capturing past effects. If the agency is committed to understanding cumulative effects over time, the current practice of portraying current conditions as the aggregate result of cumulative effects is insufficient. While it is true that cumulative effects are embedded in current conditions, this fact alone does not help us understand what factors contributed to current conditions. An exclusive focus on current conditions fails to capture effects of or lessons learned from past actions and provides no sense of how conditions have changed over time. Instead of utilizing the current condition as a baseline, McCold and Saulsbury (1996) argue that "the appropriate baseline…is that time in the past when the valued environmental attribute…was most abundant" (p. 768). This would serve as a point of comparison, even if the agency is not aiming to return to historic conditions.

4.2. Collecting and coordinating adequate monitoring information

Interviewees cited the lack of monitoring information as the primary impediment to improving CEA practice. 74% of all interviewees and 71% of interviewees with the USFS raised issues related to monitoring when discussing the challenges of conducting effective CEA. Individuals made a wide range of statements on monitoring, including the following: there is a lack of staff, time, money, and emphasis devoted to monitoring; more scientific monitoring must take place; inventory data, implementation monitoring, and post-project monitoring for effects all are needed; monitoring at landscape scales is necessary; information to help understand how the landscape arrived at current conditions would be useful; and narratives of what has been done with monitoring data and disclosure of effects, perhaps in 5-year monitoring reports, would be ideal.

Different groups of interviewees highlighted different challenges associated with monitoring. Scientists particularly emphasized the need for more population data and improved models, based on empirical data, of species–habitat relationships. Members of environmental organizations brought up both the need for more scientifically valid monitoring and consolidation of monitoring information in periodic reports to disclose effects and trends. At the Regional level of the USFS, interviewees emphasized the need to coordinate with USFS researchers to determine monitoring priorities and strategies and to coordinate monitoring activities across multiple forests as part of developing a scientifically valid and statistically sound monitoring program that utilizes limited resources effectively. Holthausen et al. (2005) write that if effective monitoring is to take place, a coordinated initiative overseen by a higher level of management, such as the Regional Offices, will be necessary. This will allow for a statistically valid sampling approach that looks at data at multiple scales. Interviewees at the Northern Region Office indicated that the wildlife program is working with USFS research, individual forests, the states, and the U.S. Fish and Wildlife Service to coordinate on species monitoring. In general, interviewees explained, both Region 1 and the USFS as a whole are moving towards improved and increased monitoring. One interviewee highlighted that the IPNF is also utilizing innovative approaches to monitoring and explained, for example, that the Myrtle Creek project (USFS, 2007b) includes a two-tiered approach to implementation that depends in part on the results of third-party monitoring after the first stage of the project is completed.

On the IPNF, interviewees emphasized the need for implementation monitoring to evaluate whether projects proceed as planned, inventory monitoring to assess baseline conditions and the status of resources, and effectiveness monitoring to understand project effects. These monitoring efforts would allow managers to do a more complete job with CEA and would provide information to support predictions in future analyses. The majority of USFS interviewees who discussed the importance of monitoring also noted that the incentives, funding, and staff are not there to complete it. One interviewee noted that strong leadership and a commitment to monitoring at the district level can make a positive difference, despite financial limitations.

A primary theme among interviewees from both the IPNF and the Regional Office was that the lack of monitoring information is the result to some extent of data being collected in an inconsistent manner or not being coordinated and made available to USFS staff in a

useful way. One staff member said that their district had multiple years of soil monitoring data but no one to consolidate or interpret it. Others pointed to the fact that forest monitoring occurs every year, but as of the summer of 2007, monitoring reports for the previous three years had not been released for the IPNF. Others simply stated that the USFS has not compiled the data it has, often due to lack of resources and emphasis on monitoring. While it is clear that additional and more strategically designed monitoring is necessary, it is also apparent that increased coordination is necessary to allow for better use of monitoring efforts that are already in place. In this way, some of the lack of monitoring information appears to be a result of what Doremus (2008) calls "leaks along the pipeline" of information supply. In other words, the problem goes beyond a lack of data collection and is one of coordination, communication, and refinement of the information that is available.

5. Opportunities for improvement

Monitoring is key for CEA because so much of the ability to determine the effects of past actions and how to limit potentially detrimental cumulative effects from present and future actions depends on collecting and interpreting monitoring data and practicing adaptive management. Increasing the monitoring capacity and activity of public land agencies is one of the most important steps needed in modernizing and improving NEPA implementation and natural resource management (CEQ, 2003). Congress and agencies must look for ways to create incentives for monitoring and provide the funding to ensure that it occurs. CEQ also will have a role to play in providing guidance and possibly regulations regarding the implementation of adaptive management. One strategy would be to make monitoring and mitigation commitments in EISs binding (Karkkainen, 2004). Such commitments would require commensurate increases in capacity in terms of both staff and funding.

Cushman and McKelvey (2009) explain that an effective monitoring strategy would include large-sample, multi-scale, and geo-referenced data on multiple ecosystem attributes. They recommend some direct monitoring of resources, given the uncertainties associated with the use of proxies or surrogates. In the case of wildlife, without direct monitoring of species there is almost nothing that provides agencies with empirical evidence of the status of populations, the effects of management actions on populations, and how populations have been affected over time. Echoing comments from some interviewees, Cushman and McKelvey (2009) also emphasize the need for large samples that provide statistically powerful inferences regarding conditions, with iterative data collection at least every five years. Such a strategy would require considerable leveraging of resources and coordination, not only within the agency, but also with other landowners and land management agencies. This type of coordination may be precisely what is necessary to significantly improve the monitoring capacity of natural resource agencies.

As for the challenges that exist due to a lack of both current and historical data, one promising avenue for filling in data gaps for wildlife populations is the potential to use genetic sampling to estimate species abundance, movement patterns, and distribution and understand to some extent how current conditions compare to the past. This approach could provide a more cost-effective way to understand the status of populations, in part because representative and large samples are relatively less important for the methodology to be effective (Schwartz et al., 2006; Noon et al., 2008). Another way to get at past impacts despite a lack of monitoring data is to better understand species–habitat relationships. Researchers at the Rocky Mountain Research Station are currently collecting population distribution data on the IPNF and building wildlife–habitat relationship models based on samples of species occurrence coupled with spatial data at multiple scales (Dr. Samuel Cushman, *personal communication*). The models could be used to estimate how populations have responded to habitat changes over time and also would strengthen the agency's ability to understand possible future impacts.

Finally, ongoing development of scientifically valid and reliable programmatic assessments and management strategies that are informed by monitoring data as it becomes available will help to provide broader scale analysis that can both incorporate project-level information and provide some context for project-level analysis. Forest plan implementation monitoring and ongoing reassessment could be one avenue for achieving programmatic assessment, improving agencies' abilities to conduct CEA and continue to move towards making adaptive management a reality.

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